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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary

Application No.

10/774,603

Applicant(s)

FOSSUM, ERIC R.

Examiner

Nelson D. Hernández Hernández

Art Unit

2622

Period for Reply -- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 04 May 2009.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 26-28, 30-35, 37, 38, 40-48 and 57-62 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 26-28, 30-35, 37, 38, 40-48 and 57-62 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 10 February 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-849)
- 3) ☐ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: _____

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on May 14, 2009 has been entered.

Response to Amendment

2. The Examiner acknowledges the amended claims filed on May 4, 2009. **Claims 26, 28, 30, 31, 33, 34, 37, 38, 44 and 48** have been amended. **Claims 1-25, 29, 36, 39 and 49-56** have been cancelled. **Claims 57-62** have been newly added.

Response to Arguments

3. Applicant's arguments with respect to independent claims 26, 37 and 44 have been considered but are moot in view of the new grounds of rejection.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the

art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

5. **Claims 60-62** are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

6. **Regarding claim 60**, claim 60 recites "...the interpolator further comprises five scalar multipliers for multiplying the digital bit values of the spectral component measurements from the photosensitive site being interpolated and the four photosensitive sites neighboring the photosensitive site being interpolated". The Examiner noted that the Specifications (*See page 15, line 14 – page 16, line 8*) recite :

"Each photosensitive site 51 assembles the twenty- four bit True Color representation in a buffer 74 (of the parallel port interface 60) as follows. The interpolator 58 transfers the bits 16-23 of the register 66 which are representative of an actual color level, to the buffer 74 without any further processing. The interpolator 58 assigns a weight via scalar multipliers to the values represented by the bits 32-39 and 8-15 of the register 66. The interpolator 58 also averages (via adders 70 and a "divide- by-two" circuitry 72) these values to estimate one of the missing color values, and stores the resultant eight bit color value in the buffer 74. The twenty-four bit representation is completed by the interpolator 58 assigning a weight to the values represented by the bits 24-31 and 0-7, average these values together, and stores the resultant eight bit color value in the buffer 75. The twenty-four bit True Color value may then be retrieved from the buffer 74 (and from the parallel port interface 60) via an I/O interface 76 that is configured to communicate with off chip devices".

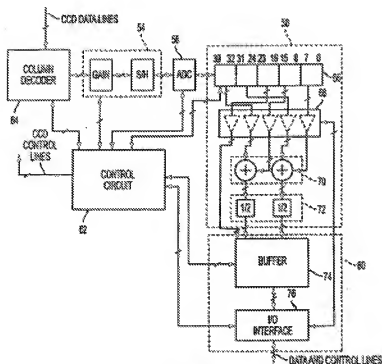


FIG. 8

It is noted that the Specification offers support for "multiplying the digital bit values of the four photosensitive sites neighboring the photosensitive site being interpolated" (*digital bit values of the four photosensitive sites neighboring the photosensitive site being interpolated being represented by bit values 0-15 and 24-39 as shown in fig. 6*) (In Page 15, lines 19-21 specifically), but does not appear to have support for "multiplying the digital bit values of the spectral component measurements from the photosensitive site being interpolated" since it is noted that the spectral component value of the photosensitive site being interpolated (*corresponding to bits 16-23*) is transferred to the buffer 74 without any further processing, that is the value of the photosensitive site being interpolated is not multiplied by a weighting coefficient but directly transmitted to the buffer. The Examiner understands that the fact the fig. 6

appear to show an amplifier (or scalar multiplier) receiving the bit values 16-23 does not necessarily suggest that the value for the pixel being interpolated is multiplied to have a particular weight value. Therefore, the Examiner understands that claim 60 contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor, at the time the application was filed, had possession of the claimed invention.

7. **Regarding claims 61 and 62**, claims 61 and 62 are also rejected under 35 U.S.C. 112, first paragraph, as they depended from claim 60.

Claim Rejections - 35 USC § 102

8. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

9. **Claims 26-28, 30-35, 37, 38, 40, 42 and 58 are rejected under 35**

U.S.C. 102(a) as being anticipated by Denyer et al., WO 97/35438 A1.

10. **Regarding claim 26**, Denyer et al. discloses an imager (*See fig. 7*), comprising:
a semiconductor substrate (*Denyer et al. discloses a semiconductor substrate by disclosing that the imager is part of a single chip camera and that the production process of the image sensor is well disposed to deposition of the color filters when the products are in silicon-wafer form. See fig. 7, page 16, lines 13-21*);

an array of photosensitive sites (*Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8*) located on the substrate (*Note that the sensor array 23 is located on the single camera chip 20 as shown in fig. 7 (See page 18, lines 5-30; also page 12, lines 1-8). This teaches that the array of photosensitive sites is located on the substrate*), the array including

a plurality of first photosensitive sites (*See fig. 1*) having a plurality of first color filters (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Green color filters as the plurality of first color filters*) arranged above said first photosensitive sites to allow only a first spectral component of light to reach said first photosensitive sites (*Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the first sensitive sites are covered with a plurality of first color filters (corresponding to green color as interpreted by the Examiner) to allow only a first spectral component (Green) of light to reach said first photosensitive sites*), wherein each first photosensitive site comprises a configuration enabling each first photosensitive site to measure the level of a first spectral component in light received (Green color components) by the respective first photosensitive site (*See page 12, lines 1-19*), and

a plurality of second photosensitive sites having a plurality of second color filters (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the*

Blue color filters as the plurality of second color filters) arranged above said second photosensitive sites to allow only a second spectral component of light to reach said second photosensitive sites (as discussed above, *Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the second sensitive sites are covered with a plurality of second color filters (corresponding to Red color as interpreted by the Examiner) to allow only a first spectral component (Green) of light to reach said first photosensitive sites*), wherein each second photosensitive site comprises a configuration enabling each second photosensitive site to measure the level of a second spectral component in light received (*Red color components*) by the respective second site (See page 12, lines 1-19), said second spectral component being different from said first spectral component (Note that the Examiner is interpreting the first color component as Green and the second color component as Red, which are different from each other); and

an interpolator (See processor subsystem 25 as shown in fig. 7. *Denyer et al. discloses performing interpolation on the color components using low-pass filter 28 and also teaches performing interpolation for obtaining the luminance components of the captured image data. See page 18, lines 5-30; see also page 12, lines 10-37; page 13, line 8 – page 14, line 10; page 15, lines 1-20) located on the substrate (Denyer et al. discloses that the processor subsystem is located on the same chip as the array of photosensitive sites. See page 18, lines 5-30; also page 16, lines 13-21) and comprising a configuration enabling the interpolator to estimate the level of the first spectral*

component (*Green color*) in the light received by at least one of the second photosensitive sites (*Photosensitive sites measuring a color other than Green (i.e. Red)*) based on at least one measurement of the first spectral component obtained respectively by at least one of the first photosensitive sites (*Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one measurement of the first spectral component (Green color) to estimate the level of the first spectral component (Green color) in the light received by at least one of the second photosensitive sites since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained (See page 12, lines 10-19). Denyer et al. also discloses that for luminance determination, the Green color component is calculated by performing interpolation of Green color components surrounding sites that do not receive Green color to obtain the luminance component for said sites (See figs. 3 and 4; page 13, line 8 – page 15, line 20)*).

11. **Regarding claim 27, Denyer et al.** discloses that the first spectral component is a primary color of light (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Green color filters as the first spectral component which is a primary color of light*).

12. **Regarding claim 28, Denyer et al.** discloses that each second photosensitive site comprises a configuration enabling each second photosensitive site to measure the level of a second spectral component in light (*Red color component*) received by the respective second photosensitive site (*Since Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors covering the array of photosensitive sites (See fig. 1). For examination purposes, the Examiner is interpreting the light received by the photosensitive sites with the Red color filters as the second spectral component in light measured by the respective second photosensitive site*), and

the interpolator further comprises a configuration enabling the interpolator configured to estimate the level of the second spectral component (*Red color*) in the light received by at least one of the first photosensitive sites (*Photosensitive sites measuring Green color*) based on at least one measurement of the second spectral component (*Red color*) obtained respectively by at least one of the second photosensitive sites (*As discussed in claim 26, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one measurement of the second spectral component (Red color) to estimate the level of the second spectral component (Red color) in the light received by at least one of the first photosensitive sites (Photosensitive sites measuring Green color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Red color) is obtained (See page 12, lines 10-19).*)

13. **Regarding claim 30, Denyer et al.** discloses a plurality of third photosensitive sites (*Since Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors covering the array of photosensitive sites (See fig. 1). For examination purposes, the Examiner is interpreting the photosensitive sites covered by a Blue color filter as third photosensitive sites*), and

the interpolator further comprises a configuration enabling the interpolator to estimate the level of the first spectral component (*Green color*) in the light received by at least one of the third photosensitive sites (*photosensitive sites measuring Blue color*) based on at least one measurement of the first spectral component (*Green color*) obtained respectively by at least one of the first photosensitive sites (*As discussed in claim 26, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one measurement of the first spectral component (Green color) to estimate the level of the first spectral component (Green color) in the light received by at least one of the third photosensitive sites (Photosensitive sites measuring Blue color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained on the photosensitive sites measuring a different color (in this case Blue color) (See page 12, lines 10-19)*), and to estimate the level of the second spectral component (*Red color*) in the light received by at least one of the third photosensitive sites (*photosensitive sites measuring Blue color*) based on at least one measurement of the second spectral component (*Red color*) obtained respectively by at least one of the

second photosensitive sites (*photosensitive sites measuring Red color*) (As discussed in claim 26, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one measurement of the second spectral component (Red color) to estimate the level of the second spectral component (Red color) in the light received by at least one of the third photosensitive sites (Photosensitive sites measuring Blue color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Red color) is obtained on the photosensitive sites measuring a different color (in this case Blue color) (See page 12, lines 10-19)).

14. **Regarding claim 31, Denyer et al.** discloses that each third photosensitive site has a plurality of third color filters (As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Blue color filters as the plurality of third color filters) arranged above said third photosensitive sites to allow only a third spectral component of light to reach said third photosensitive sites (Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the third photosensitive sites are covered with a plurality of third color filters (corresponding to Blue color as interpreted by the Examiner) to allow only a third spectral component of light (Blue color) to reach said third photosensitive

sites), and wherein each third photosensitive site comprises a configuration enabling each third photosensitive site to measure the level of a third spectral component (Blue color component) in light received by the respective third photosensitive site (*Since Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors covering the array of photosensitive sites (See fig. 1). For examination purposes, the Examiner is interpreting the light received by the photosensitive sites with the Blue color filters as the third spectral component in light measured by the respective second photosensitive site*), and

the interpolator further comprises a configuration enabling the interpolator configured to estimate the level of the third spectral component (*Blue color*) in the light received by at least one of the first photosensitive sites (*Photosensitive sites measuring Green color component*) and/or at least one of the second photosensitive sites (*Photosensitive sites measuring Red color component*) based on at least one measurement of the third spectral component obtained respectively by at least one of the third photosensitive sites (*As discussed in claim 26, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one measurement of the third spectral component (Blue color) to estimate the level of the third spectral component (Blue color) in the light received by at least one of the first photosensitive sites (Photosensitive sites measuring Green color) and/or at least one of the second photosensitive sites (Photosensitive sites measuring Red color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially*

smoothed version of the ideal color components (in this case Green color) is obtained on the photosensitive sites measuring a different color (in this case Green and Red color components) (See page 12, lines 10-19)).

15. **Regarding claim 32, Denyer et al.** discloses that the first spectral component is a first primary color of light (*As discussed in claims 26 and 27, as interpreted by the Examiner the first spectral component is the Green color which is the first primary color of light*),

the second spectral component is a second primary color of light (*As discussed in claims 26 and 28, as interpreted by the Examiner the second spectral component is the Red color which is the second primary color of light*), and

the third spectral component is a third primary color of light (*As discussed in claim 30, as interpreted by the Examiner the third spectral component is the Blue color which is the third primary color of light*), Grounds for rejecting claims 26-28, 30 and 31 apply here.

16. **Regarding claim 33, Denyer et al.** discloses a line decoder (*Readout circuit 24 as shown in fig. 7*) located on the substrate (*Note in fig. 7 that the readout circuit 24 is located on the same chip as the array of photosensitive sites 23 and the interpolator 25 (processor subsystem)*) and having at least one serial output for transferring out at least one line of measured spectral components from the array during a read out operation (*Denyer et al. discloses that five lines of five pixels forming a block are read out from the*

array of photosensitive sites 23 and output to an A/D converter (A/D block as shown in fig. 7), that would further output the digitized signals to a five-line memory (Fig. 7: 26) (See page 18, lines 5-30). Therefore, Denyer et al. discloses that the line decoder 24 has at least one serial output for transferring out at least one line of measured spectral components from the array during a read out operation as claimed); and

an A/D conversion element (A/D block as shown in fig. 7) located on the substrate (Note that the A/D block is also part of the single chip camera as shown in fig. 7, therefore is also located on the substrate) and comprising a configuration enabling the A/D conversion element to receive the at least one line of measured spectral components read out from the line decoder (Denyer et al. discloses that the five lines of said five pixels forming the block output from the readout circuit 24 are received by the A/D converter (A/D as shown in fig. 7). See page 18, lines 5-30) and output the received measurements as digital values to the interpolator (Denyer et al. discloses that the A/D converter digitizes the received signals from the readout circuit 24 and output said digitized signals to the interpolation circuits (low pass filter 28 and block 30 (which perform interpolation for determining the luminance values)). See page 18, lines 10-19), and

wherein the interpolator estimates the first spectral component levels in the second and third photosensitive sites (As discussed in claims 26 and 30, Denyer et al. discloses estimating the first spectral component levels (Green color) in the second (Photosensitive sites measuring Red color) and third (Photosensitive sites measuring Blue color) photosensitive sites),

the second spectral component levels in the first and third photosensitive sites (As discussed in claims 28 and 30, Denyer et al. discloses estimating the second spectral component levels (Red color) in the first (Photosensitive sites measuring Green color) and third (Photosensitive sites measuring Blue color) photosensitive sites), and

the third spectral component level in the first and second photosensitive sites based on the digital values received from the A/D conversion element (As discussed in claim 31, Denyer et al. discloses estimating the third spectral component levels (Blue color) in the first (Photosensitive sites measuring Green color) and second (Photosensitive sites measuring Red color) photosensitive sites) based on the digital values received from the A/D conversion element (As shown in fig. 7, the interpolation performed by the low pass filter 28 and block 30 (which perform interpolation for determining the luminance values), perform the color estimation based on the digital values output by the A/D converter (A/D block), which output the digital values to the 5-line memory 27 and the values stored in the 5-line memory are read out to the interpolation elements. See page 18, lines 5-30).

17. **Regarding claim 34, Denyer et al.** discloses a line decoder (Readout circuit 24 as shown in fig. 7) located on the substrate (Note in fig. 7 that the readout circuit 24 is located on the same chip as the array of photosensitive sites 23 and the interpolator 25 (processor subsystem)) and having at least one serial output for transferring out at least one line of measured spectral components from the array during a read out operation (Denyer et al. discloses that five lines of five pixels forming a block are read out from the

array of photosensitive sites 23 and output to an A/D converter (A/D block as shown in fig. 7), that would further output the digitized signals to a five-line memory (Fig. 7: 26) (See page 18, lines 5-30). Therefore, Denyer et al. discloses that the line decoder 24 has at least one serial output for transferring out at least one line of measured spectral components from the array during a read out operation as claimed); and

an A/D conversion element (A/D block as shown in fig. 7) located on the substrate (Note that the A/D block is also part of the single chip camera as shown in fig. 7, therefore is also located on the substrate) and comprising a configuration enabling the A/D conversion element to receive the at least one line of measured spectral components read out from the line decoder (Denyer et al. discloses that the five lines of said five pixels forming the block output from the readout circuit 24 are received by the A/D converter (A/D as shown in fig. 7). See page 18, lines 5-30) and output the received measurements as digital values to the interpolator (Denyer et al. discloses that the A/D converter digitizes the received signals from the readout circuit 24 and output said digitized signals to the interpolation circuits (low pass filter 28 and block 30 (which perform interpolation for determining the luminance values)). See page 18, lines 10-19), and

wherein the interpolator estimates the first spectral component levels in the second photosensitive sites based on the digital values received from the A/D conversion element (As discussed in claims 26 and 30, Denyer et al. discloses estimating the first spectral component levels (Green color) in the second

photosensitive sites (Photosensitive sites measuring Red color). See page 12, lines 10-19).

18. **Regarding claim 35, Denyer et al.** discloses a line decoder (*Readout circuit 24 as shown in fig. 7*) located on the substrate (*Note in fig. 7 that the readout circuit 24 is located on the same chip as the array of photosensitive sites 23 and the interpolator 25 (processor subsystem)*) and having at least one serial output for transferring out at least one line of measured spectral components from the array during a read out operation (*Denyer et al. discloses that five lines of five pixels forming a block are read out from the array of photosensitive sites 23 and output to an A/D converter (A/D block as shown in fig. 7), that would further output the digitized signals to a five-line memory (Fig. 7: 26) (See page 18, lines 5-30). Therefore, Denyer et al. discloses that the line decoder 24 has at least one serial output for transferring out at least one line of measured spectral components from the array during a read out operation as claimed*), wherein the at least one serial output of the line decoder transfers out either several sequential lines or a block of measured spectral components from the array during each read out operation (*As discussed above, Denyer et al. discloses that five lines of five pixels forming a block are read out from the array of photosensitive sites 23 and output to the A/D converter. Therefore, Denyer et al. discloses that at least one serial output of the line decoder transfers out either several sequential lines (since the line decoder transmits data (five pixels per line) from five sequential lines) or a block of measured spectral components from the array during each read out operation (since the five lines output belong to a*

block in the array of photosensitive sites, the block being used to estimate the missing color values). See page 18, lines 5-30).

19. **Regarding claim 37, Denyer et al.** discloses an imager (See figs. 1 and 7), comprising:

a semiconductor substrate (Denyer et al. discloses a semiconductor substrate by disclosing that the imager is part of a single chip camera and that the production process of the image sensor is well disposed to deposition of the color filters when the products are in silicon-wafer form. See fig. 7, page 16, lines 13-21);

a plurality of first photosensitive sites (Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8) located on the substrate (Note that the sensor array 23 is located on the single camera chip 20 as shown in fig. 7 (See page 18, lines 5-30; also page 12, lines 1-8). This teaches that the plurality of first photosensitive sites is located on the substrate), said plurality of first photosensitive sites (See fig. 1) having a plurality of first color filters (As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Green color filters as the plurality of first color filters) arranged above said first photosensitive sites to allow only a first spectral component of light to reach said first photosensitive sites (Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the first sensitive sites are covered with a plurality of first color filters

(corresponding to green color as interpreted by the Examiner) to allow only a first spectral component (Green) of light to reach said first photosensitive sites), wherein each first photosensitive site comprises a configuration enabling each first photosensitive site to measure the level of a first spectral component (Green color components) in light received by the respective first photosensitive site (See page 12, lines 1-19);

a plurality of second photosensitive sites (Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8) located on the substrate (Note that the sensor array 23 is located on the single camera chip 20 as shown in fig. 7 (See page 18, lines 5-30; also page 12, lines 1-8). This teaches that the plurality of second photosensitive sites is located on the substrate), said plurality of second photosensitive sites having a plurality of second color filters (As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Blue color filters as the plurality of second color filters) arranged above said second photosensitive sites to allow only a second spectral component of light to reach said second photosensitive sites (as discussed above, Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the second sensitive sites are covered with a plurality of second color filters (corresponding to Red color as interpreted by the Examiner) to allow only a first spectral component (Green) of light to reach said first photosensitive sites), wherein each second photosensitive site comprises a

configuration enabling each second photosensitive site to measure the level of a second spectral component (*Red color component*) in light received by the respective second photosensitive site, said second spectral component being different from said first spectral component (*Note that the Examiner is interpreting the first color component as Green and the second color component as Red, which are different from each other*); and

an interpolator (*See processor subsystem 25 as shown in fig. 7. Denyer et al. discloses performing interpolation on the color components using low-pass filter 28 and also teaches performing interpolation for obtaining the luminance components of the captured image data. See page 18, lines 5-30; see also page 12, lines 10-37; page 13, line 8 – page 14, line 10; page 15, lines 1-20*) located on the substrate (*Denyer et al. discloses that the processor subsystem is located on the same chip as the array of photosensitive sites. See page 18, lines 5-30; also page 16, lines 13-21*) and comprising a configuration enabling the interpolator to receive digital data (digitized by A/D converter (*A/D block as shown in fig. 7*)) representing the spectral component levels measured in the first photosensitive sites (*photosensitive sites measuring Green color*) and the second photosensitive sites (*photosensitive sites measuring Red color*) (*As shown in fig. 7, Denyer et al. discloses that the color signals are read from the array of photosensitive sites 23 by a readout circuit 24 and digitized by an A/D converter (A/D block), the digital signals stored in a 5-line memory 26 and then transmitted to the interpolator (Note that in the processing subsystem, the interpolation is performed by a low pass filter 28 and block 30 (which perform interpolation for determining the*

luminance values) (See page 18, lines 5-30). This teaches that the interpolator receives digital representing the spectral component levels measured in the first photosensitive sites as claimed), and to estimate the level of the first spectral component (Green color) in the light received by at least one of the second photosensitive sites (Photosensitive sites measuring a color other than Green (i.e. Red)) based on at least one digitized measurement of the first spectral component obtained respectively by at least one of the first photosensitive sites (Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the first spectral component (Green color) to estimate the level of the first spectral component (Green color) in the light received by at least one of the second photosensitive sites since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained (See page 12, lines 10-19). Denyer et al. also discloses that for luminance determination, the Green color component is calculated by performing interpolation of Green color components surrounding sites that do not receive Green color to obtain the luminance component for said sites (See figs. 3 and 4; page 13, line 8 – page 15, line 20; page 18, lines 5-30)).

20. **Regarding claim 38, Denyer et al.** discloses a plurality of third photosensitive sites (Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8), said plurality of third photosensitive sites having a plurality of third color filters (As shown in fig. 1,

Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Blue color filters as the plurality of third color filters) arranged above said third photosensitive sites to allow only a third spectral component of light to reach said third photosensitive sites (Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the third photosensitive sites are covered with a plurality of third color filters (corresponding to Blue color as interpreted by the Examiner) to allow only a third spectral component of light (Blue color) to reach said third photosensitive sites), wherein each third photosensitive site comprises a configuration enabling each third photosensitive site to measure the level of a third spectral component (Blue color component) in light received by the respective third photosensitive site (Since Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors covering the array of photosensitive sites (See fig. 1). For examination purposes, the Examiner is interpreting the light received by the photosensitive sites with the Blue color filters as the third spectral component in light measured by the respective second photosensitive site), and

wherein the interpolator further comprises a configuration enabling the interpolator to estimate:

the level of the first spectral component (Green color) in the light received by at least one of the third photosensitive sites (photosensitive sites measuring Blue color) based on at least one digitized measurement of the first spectral component

(Green color being digitized by A/D converter as shown in fig. 7. See page 18, lines 5-30) obtained respectively by at least one of the first photosensitive sites (photosensitive sites measuring Green color) (As discussed in claim 37, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the first spectral component (Green color digitized by the A/D converter as shown in fig. 7) to estimate the level of the first spectral component (Green color) in the light received by at least one of the third photosensitive sites (Photosensitive sites measuring Blue color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained on the photosensitive sites measuring a different color (in this case Blue color) (See page 12, lines 10-19; page 18, lines 5-30)),

the level of the second spectral component (Red color) in the light received by at least one of the third photosensitive sites (photosensitive sites measuring Blue color) based on at least one digitized measurement of the second spectral component (Red color being digitized by A/D converter as shown in fig. 7. See page 18, lines 5-30) obtained respectively by at least one of the second photosensitive sites (photosensitive sites measuring Red color) (As discussed in claim 37, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the second spectral component (Red color digitized by the A/D converter as shown in fig. 7) to estimate the level of the second spectral component

(Red color) in the light received by at least one of the third photosensitive sites (Photosensitive sites measuring Blue color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Red color) is obtained on the photosensitive sites measuring a different color (in this case Blue color) (See page 12, lines 10-19; page 18, lines 5-30)), and

the level of the third spectral component (Blue color) in the light received by at least one of the first photosensitive sites (photosensitive sites measuring Green color) and/or at least one of the second photosensitive sites (photosensitive sites measuring Red color) based on at least one digitized measurement of the third spectral component (Blue color being digitized by A/D converter as shown in fig. 7. See page 18, lines 5-30) obtained respectively by at least one of the third photosensitive sites (photosensitive sites measuring Blue color) (As discussed in claim 37, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the third spectral component (Blue color digitized by the A/D converter as shown in fig. 7) to estimate the level of the third spectral component (Blue color) in the light received by at least one of the first photosensitive sites (Photosensitive sites measuring Green color) and/or at least one of the second photosensitive sites (Photosensitive sites measuring Red color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained on the photosensitive sites

measuring a different color (in this case Green and Red color components) (See page 12, lines 10-19; page 18, lines 5-30)).

21. **Regarding claim 40, Denyer et al.** discloses that the first spectral component is a first primary color of light (*As discussed in claims 37 and 38, as interpreted by the Examiner the first spectral component is the Green color which is the first primary color of light*),

the second spectral component is a second primary color of light (*As discussed in claims 37 and 38, as interpreted by the Examiner the second spectral component is the Red color which is the second primary color of light*), and

the third spectral component is a third primary color of light (*As discussed in claims 37 and 38, as interpreted by the Examiner the third spectral component is the Blue color which is the third primary color of light*), Grounds for rejecting claims 37 and 38 apply here.

22. **Regarding claim 42, Denyer et al.** discloses that the interpolator includes at least one serial register (*Denyer et al. discloses a plurality of five-pixel registers (Fig. 7: 27)) for storing digital bit values representing the spectral component measurements from a photosensitive site being interpolated and the photosensitive sites neighboring the photosensitive site being interpolated (Denyer et al. discloses that a 5 X 5 block is read out from the memory by 5-pixel registers 27, the block including a photosensitive*

site being interpolated and the photosensitive sites neighboring the photosensitive site being interpolated. See page 12, lines 10-19; page 18, lines 5-30).

23. **Regarding claim 58, Denyer et al.** discloses that the interpolator further comprises a configuration enabling the interpolator to estimate the level of the first spectral component (*Green color*) in the light received by at least one of the second photosensitive sites (*photosensitive sites measuring Red color*) based on a measurement of the first spectral component (*Green color*) obtained respectively by only a plurality of the first photosensitive sites (*Denyer et al. discloses that the interpolator estimates the level of the first spectral (Green color) component in the light received by at least one of the second photosensitive sites (photosensitive sites measuring Red color) based on a measurement of the first spectral component (Green color) obtained respectively a plurality of the first photosensitive sites by teaching that the missing colors are estimated by applying a lowpass filter to the surrounding photosensitive sites of the color being estimated (See page 12, lines 10-19).*

Claim Rejections - 35 USC § 103

24. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

25. Claims 41 and 57 are rejected under 35 U.S.C. 103(a) as being unpatentable over Denyer et al., WO 97/35438 A1 in view of Acharya, US Patent 6,091,851.

26. **Regarding claim 41**, Denyer et al. does not explicitly disclose that the interpolator output twenty four bits of color data for each photosensitive site, with each color value being represented by eight bits.

However, **Acharya** teaches the concept of performing color recovery of imager captured by a camera (*Fig. 3: 330*) using a single sensor having a Bayer pattern color filter array in order to obtain a full resolution image from an object (*Fig. 3: 340*) being photographed, wherein the individual color components of each pixel area represented by eight bits (*in order to represent a color intensity range from 0-255*) and the pixels of the image after interpolation is performed would have a total resolution of twenty four bits (*Col. 1, lines 4-48; col. 2, lines 40-52; col. 3, lines 16-41; col. 5, line 26 – col. 6, line 26; col. 9, lines 1-8*). Acharya also discloses that the interpolation method can be performed by hardware and firmware and that the interpolation method can be performed by the camera processor (*Fig. 3: 32*) (*Col. 10, lines 7-17*).

Therefore, taking the combined teaching of Denyer et al. in view of Acharya as a whole, one of an ordinary skill in the art, after appreciating the advantages of the

interpolation method of Acharya, would find obvious at the time the invention was made to modify the imager of Denyer et al. by having the interpolator output twenty four bits of color data for each photosensitive site, with each color value being represented by eight bits. The motivation to do so would have been to have a desirable amount of color intensity values (256 color intensity values) for each color of each pixel in the image and to better represent luminance in recovering missing color components to have the output image to better resemble the original color of the object prior to its image capture.

27. **Regarding claim 57**, Although Denyer et al. discloses that the interpolator estimates the level of the first spectral (*Green color*) component in the light received by at least one of the second photosensitive sites (*photosensitive sites measuring Red color*) based on a measurement of the first spectral component (*Green color*) obtained respectively a plurality of the first photosensitive sites by teaching that the missing colors are estimated by applying a lowpass filter to the surrounding photosensitive sites of the color being estimated (*See page 12, lines 10-19*), Denyer et al. does not explicitly disclose that the estimation is based on only two of the first photosensitive sites.

However, **Acharya** teaches the concept of performing color interpolation to obtain missing color components on a captured image and discusses the use of only two pixels for estimating color components as a simple approach (*Acharya teaches that for a missing Red color component, the two nearest Red color pixel value would be averaged to estimate said missing Red color component, and the same would be*

performed for Blue and Green color components to obtain an approximation of the original object's true color. See col. 1, line 49 – col. 2, line 7).

Therefore, taking the combined teaching of Denyer et al. in view of Acharya as a whole, it would have been obvious to one of an ordinary skill in the art at the time the invention was made to apply the concept of using only two color components to approximate an object's true color component missing at a particular pixel location as taught by Acharya to modify the interpolator of Denyer to estimate the level of the first spectral component (*Green color*) in the light received by at least one of the second photosensitive sites (*photosensitive sites measuring Red color*) based on a measurement of the first spectral component (*Green color*) obtained respectively by only two of the first photosensitive sites. The motivation to do so would have been to calculate the missing color components using a simple interpolation method that would reduce the time for estimating the missing color components as an alternative to using a 5 x 5 pixel kernel, thus allowing increasing the speed of the interpolation process.

28. Claims 43 and 59-62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Denyer et al., WO 97/35438 A1 in view of Sakurai et al., US Patent 5,990,946.

29. Regarding claim 43, Denyer et al. does not explicitly disclose that for estimating a spectral component level for a photosensitive site, the interpolator digitally weights the values of the spectral component being estimated, as measured by the photosensitive sites providing the measurements and which are currently stored in the at least one

serial register, based on the distances of the photosensitive sites providing the measurements from the photosensitive site for which the spectral component is being estimated.

However, **Sakurai et al.** teaches a digital camera (*See figs. 12 and 14*), comprising an imager (*See fig. 12: 104 and fig. 14: 90*) for capturing an image; an A/D converter (*Fig. 12: 107*) for digitizing the color signals received from the imager (*Col. 7, lines 21-60*) to be memorized in a memory (*254 as shown in fig. 12; see also memory 91 as shown in fig. 14*) and a color interpolation circuit (*Color interpolation circuit 3 as shown in figs. 14 and 15*) for estimating the color components missing on each photosensitive site (*Col. 8, line 17 – col. 9, line 26*). Sakurai et al. further teaches that the color interpolation circuit comprises five multipliers (*See fig. 17: 12-16*) for weighting the values of the spectral component being estimated, as measured by the photosensitive sites providing the measurements and which are currently stored in at least one serial register (*Sakurai et al. discloses using a plurality of delay units (Fig. 17: 8-11) for storing the spectral components being estimated (See col. 10, lines 9-27). Since the delay units are used to hold the spectral components being estimated for further performing interpolation to said spectral components, the Examiner is reading the delay units 8-11 as a serial register since the spectral components measured, which are received from the memory, are shifted from each of the delay units to be output to the multipliers 8-11 for weighting the spectral components. See col. 10, lines 9-27*), based on the distances of the photosensitive sites providing the measurements from the photosensitive site for which the spectral component is being estimated (*In col. 9, line*

48 – col. 10, line 6, Sakurai et al. teaches a plurality of equations that are applied to the spectral components by the interpolation circuit. It is noted that a lower weighting coefficient is applied to spectral components far from the target pixel to be estimated. For example the estimation for an n2 line (See lines in the portion of fig. 16 below), would be defined as:

$$Mg = 1/2(1/2Mg12 + 1/2Mg14) + 1/2(1/4Mg31 + 1/2Mg33 + 1/4Mg35)$$

$$G = 1/2(1/4G11 + 1/2G13 + 1/4G15) + 1/2(1/2G32 + 1/2G34)$$

$$Ye = 1/2(1/2Ye22 + Ye24)$$

$$Cy = 1/2(1/2Cy21 + Cy23 + 1/2Cy25),$$

It is noted that Mg31 and Mg35 are receiving a lower weighting coefficient (1/4), which is assigned based on the distance from the target pixel since said pixels are far from the target pixel and pixels that are closer to the target pixel are receiving a larger weighting coefficient (1/2). The same occurs for other estimations in the same line as well as other lines.).

FIG.16

G 11	Mg 12	G 13	Mg 14	G 15	Mg 16	→ n1
Cy 21	Ye 22	Cy 23	Ye 24	Cy 25	Ye 26	→ n2
Mg 31	G 32	Mg 33	G 34	Mg 35	G 36	→ n3
Cy 41	Ye 42	Cy 43	Ye 44	Cy 45	Ye 46	→ n4
G 51	Mg 52	G 53	Mg 54	G 55	Mg 56	→ n5
Cy 61	Ye 62	Cy 63	Ye 64	Cy 65	Ye 66	→ n6

Applying a weighting coefficient that is associated to the distance from the target pixel is advantageous because it would provide a smooth (natural) continuity for the image formed of the filtered spectral components.

Therefore, taking the combined teaching of Denyer et al. in view of Sakurai et al. as a whole, it would have been obvious to one of an ordinary skill in the art at the time the invention was made to apply the concept of weighting the values of the spectral component being estimated, which are currently stored in a serial register, based on the distances of the photosensitive sites providing the measurements from the photosensitive site for which the spectral component is being estimated as taught by Sakurai et al. to modify the teaching of Denyer et al. to have the interpolator digitally weighting the values of the spectral component being estimated, as measured by the photosensitive sites providing the measurements and which are currently stored in the at least one serial register, based on the distances of the photosensitive sites providing the measurements from the photosensitive site for which the spectral component is being estimated. The motivation to do so would have been to provide a smooth (natural) continuity for the image formed of the filtered spectral components.

Regarding claims 59-62, Denyer et al. discloses the interpolator comprises at least one serial register (*Denyer et al. discloses a plurality of five-pixel registers (Fig. 7: 27)*) for storing digital bit values representing the spectral component measurements from a photosensitive site being interpolated and a plurality photosensitive sites neighboring the photosensitive site (*24 photosensitive sites neighboring the*

photosensitive site being interpolated in the 5 x 5 block) being interpolated (Denyer et al. discloses that the color signals are read from the array of photosensitive sites 23 by a readout circuit 24 and digitized by an A/D converter (A/D block), the digital signals stored in a 5-line memory 26 and then transmitted to the interpolator (Note that in the processing subsystem, the interpolation is performed by a low pass filter 28 and block 30 (which perform interpolation for determining the luminance values) (See page 18, lines 5-30). This teaches that the register stores digital bit values representing the spectral component measurements from a photosensitive site being interpolated and the photosensitive sites neighboring the photosensitive site being interpolated). Denyer et al. does not explicitly disclose the plurality of photosensitive sites stored in the at least one serial register are four photosensitive sites;

that the interpolator further comprises five scalar multipliers for multiplying the digital bit values of the spectral component measurements from the photosensitive site being interpolated and the four photosensitive sites neighboring the photosensitive site being interpolated;

a first adder for adding the digital bit value of a first of the four photosensitive sites neighboring the photosensitive site being interpolated to a second of the four photosensitive sites neighboring the photosensitive site and a second adder for adding the digital bit value of a third of the four photosensitive sites neighboring the photosensitive site being interpolated to a fourth of the four photosensitive sites neighboring the photosensitive site; and

a first dividing circuit for dividing in half a summation of the first and second of the four photosensitive sites neighboring the photosensitive site being interpolated and a second dividing circuit for dividing in half a summation of the third and fourth of the four photosensitive sites neighboring the photosensitive site being interpolated.

However, **Sakurai et al.** teaches a digital camera (See *figs. 12 and 14*), comprising an imager (See *fig. 12: 104 and fig. 14: 90*) for capturing an image; an A/D converter (*Fig. 12: 107*) for digitizing the color signals received from the imager (*Col. 7, lines 21-60*) to be memorized in a memory (*254 as shown in fig. 12; see also memory 91 as shown in fig. 14*) and a color interpolation circuit (*Color interpolation circuit 3 as shown in figs. 14 and 15*) for estimating the color components missing on each photosensitive site (*Col. 8, line 17 – col. 9, line 26*). Sakurai et al. further teaches using a plurality of delay units (*Fig. 17: 8-11*) for shifting five spectral components, a color component being interpolated and four color components neighboring the color component being estimated (See *col. 10, lines 9-27; Since the delay units are used to hold the spectral component being estimated and the four spectral components neighboring the spectral component being estimated for further performing interpolation to said spectral components, the Examiner is reading the delay units 8-11 as a serial register since the spectral components measured, which are received from the memory, are shifted from each of the delay units to be output to a plurality of multipliers 8-11 for weighting the spectral components. See col. 10, lines 9-41*). Sakurai et al. further teaches that the color interpolation circuit further comprises a plurality of interpolation filters (*5-7 as shown in fig. 17*) each five scalar multipliers (*Coefficient setting units 12-*

16 as shown in fig. 17) for multiplying the digital bit values of the spectral component measurements from the photosensitive site being interpolated (it is noted that the interpolation color filters 5-7 contain the same structure for interpolating missing components (See col. 10, lines 9-41) and that the color component that is being interpolated would receive a weight value when used for estimating the same spectral component missing at a different location since the output of said interpolation color filters 5-7 are further used to obtain the values of the spectral components missing in the obtained image data to satisfy the equations shown in col. 9, line 47 - col. 10, line 6 (See also col. 10, lines 9-41). Therefore, Sakurai et al. teaches that a scalar multiplier multiplies the digital bit values of the spectral component measurements from the photosensitive site being interpolated) and the four photosensitive sites neighboring the photosensitive site being interpolated (Sakurai et al. teaches that the coefficient setting units 12-16 are used to apply a weighting value to the spectral components being interpolated. Coefficient setting units 12 and 16 apply a $1/4$ weighting value and coefficient setting units 13-15 apply a $1/2$ weighting value to the spectral components being interpolated. See fig. 17; see also col. 9, line 27 – col. 10, line 36. As discussed above, it is noted that Sakurai et al. teaches combining the outputs of the interpolation filters to yield a particular color component. As shown in fig. 7, the color components can be obtained from four values of the spectral components. For example, to satisfy the equation for estimating a Y_e color component,

$$Y_e = \frac{1}{2} (\frac{1}{2}Y_{e42} + \frac{1}{2}Y_{e44}) + \frac{1}{2} (\frac{1}{2}Y_{e62} + \frac{1}{2}Y_{e64}),$$

it is noted that four values of the Y_e spectral components have been assigned a particular weight value ($\frac{1}{2}$) and have been

interpolated to estimated the Ye component missing at position G53 (line n5 as shown in fig. 16). This also teaches that the estimation for the different color components may be performed by the use of different amount of spectral components measured by the photosensitive sites and furthermore, Sakurai et al. further teaches that the estimation may be performed by using either one-dimensional filter, two-dimensional filters and while the block as taught corresponds to lines of 5 pixels, the lines may be of 3 or 7 pixels (See col. 10, lines 33-41). This suggests the use of any desired amount of photosensitive site values for estimating the missing color components in the image));

a first adder (See fig. 17: 17) for adding the digital bit value of a first of the four photosensitive sites (corresponding to spectral component being weighted by coefficient setting unit 12 as shown in fig. 17) neighboring the photosensitive site being interpolated to a second of the four photosensitive sites (corresponding to spectral component being weighted by coefficient setting unit 16 as shown in fig. 17) neighboring the photosensitive site and a second adder (See fig. 17: 18) for adding the digital bit value of a third of the four photosensitive sites (corresponding to spectral component being weighted by coefficient setting unit 13 as shown in fig. 17) neighboring the photosensitive site being interpolated to a fourth of the four photosensitive sites (corresponding to spectral component being weighted by coefficient setting unit 15 as shown in fig. 17) neighboring the photosensitive site (See fig. 17; see also col. 9, line 27 – col. 10, line 3); and

a first dividing circuit (Coefficient setting unit 19 as shown in fig. 17) for dividing in half a summation of the first and second of the four photosensitive sites (corresponding

to spectral components being weighted by coefficient setting units 12 and 16 as shown in fig. 17) neighboring the photosensitive site being interpolated and a second dividing circuit (Coefficient setting unit 20 as shown in fig. 17) for dividing in half a summation of the third and fourth of the four photosensitive sites (corresponding to spectral components being weighted by coefficient setting units 13 and 15 as shown in fig. 17) neighboring the photosensitive site being interpolated.

Therefore, taking the combined teaching of Denyer et al. in view of Sakurai et al., after acknowledging the teaching of estimating the missing color components in an image by using the values a plurality spectral components being weighted by a plurality of multipliers, added and divided by half and that the estimation may be performed by different amounts of values of a spectral component, including four values to obtain the missing color component at a particular location as taught by Sakurai et al., it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the interpolator of Denyer et al. to have the plurality of photosensitive sites stored in the at least one serial register are four photosensitive sites; to have the interpolator with a structure comprising five scalar multipliers for multiplying the digital bit values of the spectral component measurements from the photosensitive site being interpolated and the four photosensitive sites neighboring the photosensitive site being interpolated; a first adder for adding the digital bit value of a first of the four photosensitive sites neighboring the photosensitive site being interpolated to a second of the four photosensitive sites neighboring the photosensitive site and a second adder for adding the digital bit value of a third of the four photosensitive sites neighboring the

photosensitive site being interpolated to a fourth of the four photosensitive sites neighboring the photosensitive site; and a first dividing circuit for dividing in half a summation of the first and second of the four photosensitive sites neighboring the photosensitive site being interpolated and a second dividing circuit for dividing in half a summation of the third and fourth of the four photosensitive sites neighboring the photosensitive site being interpolated. The motivation to do so would have been to provide an alternative structure to the interpolator in Denyer et al. to perform the estimation of the missing color components with the purpose of producing a smooth (natural) continuity for the image formed of the filtered spectral components.

30. Claims 44-48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Denyer et al., WO 97/35438 A1 in view of Denyer et al., WO 97/20434 A1 (hereinafter referred as Denyer et al. '434).

31. Regarding claim 44, Denyer et al. discloses an imaging device (See figs. 1 and 7), comprising:

An imager (See fig. 7: 23) which comprises

a substrate (*Denyer et al. discloses a semiconductor substrate by disclosing that the imager is part of a single chip camera and that the production process of the image sensor is well disposed to deposition of the color filters when the products are in silicon-wafer form. See fig. 7, page 16, lines 13-21;*

an M x N array of photosensitive sites (See fig. 1; see also fig. 7: 23) located on the substrate (*Note that the sensor array 23 is located on the single camera*

chip 20 as shown in fig. 7 (See page 18, lines 5-30; also page 12, lines 1-8), the array including

a plurality of first photosensitive sites (Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8) located on the substrate (Note that the sensor array 23 is located on the single camera chip 20 as shown in fig. 7 (See page 18, lines 5-30; also page 12, lines 1-8). This teaches that the plurality of first photosensitive sites is located on the substrate), said plurality of first photosensitive sites (See fig. 1) having a plurality of first color filters (As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Green color filters as the plurality of first color filters) arranged above said first photosensitive sites to allow only a first spectral component of light to reach said first photosensitive sites (Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the first sensitive sites are covered with a plurality of first color filters (corresponding to green color as interpreted by the Examiner) to allow only a first spectral component (Green) of light to reach said first photosensitive sites), wherein each first photosensitive site comprises a configuration enabling each first photosensitive site to measure the level of a first spectral component (Green color components) in light received by the respective first photosensitive site (See page 12, lines 1-19);

a plurality of second photosensitive sites (*Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8*) located on the substrate (*Note that the sensor array 23 is located on the single camera chip 20 as shown in fig. 7 (See page 18, lines 5-30; also page 12, lines 1-8). This teaches that the plurality of second photosensitive sites is located on the substrate*), said plurality of second photosensitive sites having a plurality of second color filters (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Blue color filters as the plurality of second color filters*) arranged above said second photosensitive sites to allow only a second spectral component of light to reach said second photosensitive sites (as discussed above, *Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page 12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the second sensitive sites are covered with a plurality of second color filters (corresponding to Red color as interpreted by the Examiner) to allow only a first spectral component (Green) of light to reach said first photosensitive sites*), wherein each second photosensitive site comprises a configuration enabling each second photosensitive site to measure the level of a second spectral component (*Red color component*) in light received by the respective second photosensitive site, said second spectral component being different from said first spectral component (*Note that the Examiner is interpreting the first color component as Green and the second color component as Red, which are different from each other*); and

an interpolator (See processor subsystem 25 as shown in fig. 7. Denyer et al. discloses performing interpolation on the color components using low-pass filter 28 and also teaches performing interpolation for obtaining the luminance components of the captured image data. See page 18, lines 5-30; see also page 12, lines 10-37; page 13, line 8 – page 14, line 10; page 15, lines 1-20) located on the substrate (Denyer et al. discloses that the processor subsystem is located on the same chip as the array of photosensitive sites. See page 18, lines 5-30; also page 16, lines 13-21) and comprising a configuration to receive digitized color component values (digitized by A/D converter (A/D block as shown in fig. 7)) corresponding to the measurements obtained in the first photosensitive sites (photosensitive sites measuring Green color) and the second photosensitive sites (photosensitive sites measuring Red color) (As shown in fig. 7, Denyer et al. discloses that the color signals are read from the array of photosensitive sites 23 by a readout circuit 24 and digitized by an A/D converter (A/D block), the digital signals stored in a 5-line memory 26 and then transmitted to the interpolator (Note that in the processing subsystem, the interpolation is performed by a low pass filter 28 and block 30 (which perform interpolation for determining the luminance values) (See page 18, lines 5-30). This teaches that the interpolator receives digital representing the spectral component levels measured in the first photosensitive sites as claimed), to estimate the level of the first color component (Green color) in the light received by at least one of the second photosensitive sites (Photosensitive sites measuring a color other than Green (i.e. Red)) based on at least one digitized color component obtained respectively by at least one of the first photosensitive sites (Denyer et al. discloses

applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the first spectral component (Green color) to estimate the level of the first spectral component (Green color) in the light received by at least one of the second photosensitive sites since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained (See page 12, lines 10-19). Denyer et al. also discloses that for luminance determination, the Green color component is calculated by performing interpolation of Green color components surrounding sites that do not receive Green color to obtain the luminance component for said sites (See figs. 3 and 4; page 13, line 8 – page 15, line 20; page 18, lines 5-30)) and to estimate the level of the second color component (Red color) in the light received by at least one of the first photosensitive sites (Photosensitive sites measuring Green color) based on at least one digitized color component obtained respectively from at least one of the second photosensitive sites (Photosensitive sites measuring Red color) (As discussed above, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized second color component (Red color digitized by A/D converter as shown in fig. 7) to estimate the level of the second color component (Red color) in the light received by at least one of the first photosensitive sites (Photosensitive sites measuring Green color) since Denyer et al. discloses that by performing low-pass filter

to the color components, a spatially smoothed version of the ideal color components (in this case Red color) is obtained (See page 12, lines 10-19)).

Denyer et al. does not explicitly disclose a display for displaying an image on an array of $M \times N$ pixels.

However, **Denyer et al. '434** discloses an imaging device (See *figs. 3 and 4*), comprising:

a display (*Fig. 4: 30*) for displaying an image on an array of $M \times N$ pixels (*page 11, line 33 – page 12, line 25*); and

an imager (*Fig. 3: 1 and 4: 1*) which comprises

a substrate (*by teaching that the imaging array is located in a chip, Denyer et al. discloses a semiconductor substrate; see page 13, lines 1-22*),

an $M \times N$ array of photosensitive sites located on the substrate (*fig. 3 shows an $M \times N$ array of pixels 2*), the array including

a plurality of first photosensitive sites located in the substrate (*the array in Denyer et al. is divided into three kind of photosensitive sites (red, green and blue); see fig. 2; page 10, line 23 – page 12, line 32*), wherein each first photosensitive site is configured to measure the level of a first color (*i.e. green*) component in light received by the respective first photosensitive site, and

a plurality of second photosensitive sites (*the array in Denyer et al. is divided into three kind of photosensitive sites (red, green and blue); see fig. 2; page 10, line 23 – page 12, line 32*) located in the substrate, wherein each second photosensitive site is configured to measure the level of a second color component (*i.e.*

red color) in light received by the respective second photosensitive site (taking in consideration green, red and blue as a first, second and third spectral components for examining purposes, the second spectral components can be read as red. Denyer et al. discloses measuring red, green and blue colors as discussed in claim 26 above), said second spectral component being different from said first spectral component (the array in Denyer et al. is divided into three kind of photosensitive sites (red, green and blue); see fig. 2; page 10, line 23 – page 12, line 32. This teaches that the second spectral component being different from said first spectral component as claimed since each photosensitive site is receiving a single color spectral of the three colors that the full array receives); and

an interpolator (Denyer et al. discloses a processing unit (Fig. 4: 28) to perform color interpolation to the red, green and blue signals to form synchronous, parallel color channel signals for the video signal before being output to a display unit (Fig. 4: 30); page 11, line 33 – page 12, line 25) located on the substrate (Denyer et al. discloses that the processing unit can be incorporated in the same chip, where the imaging array is located; page 13, lines 1-22) and configured to receive digitized color component values (output from an A/D converter 26 as shown in fig. 4; page 11, line 33 – page 13, line 23) corresponding to the measurements obtained in the first and second photosensitive sites, to estimate the level of the color component in the light received by at least one of the second photosensitive sites based on at least one digitized color component value obtained respectively from at least one of the other photosensitive sites, and to estimate the level of the second color component in the light received by at

least one of the other photosensitive sites based on at least one digitized color component value obtained respectively from at least one of other photosensitive sites (*Denyer et al. discloses reconstructing the image colors of each pixels by performing interpolation to obtain an RGB value for each pixel location*) (Page 10, line 23 – page 13, line 22).

Having an imaging device including a display for displaying an image on an array of $M \times N$ pixels is advantageous because it improve the portability of the imaging device by allowing the user to review the captured image data on the same device.

Therefore, taking the combined teaching of Denyer et al. in view of Denyer et al. '434 as a whole, it would have been obvious to one of an ordinary skill in the art at the time the invention was made to apply the concept of having an imaging device with a display for displaying the images captured by said imaging device as taught in Denyer et al. '434 to modify the imaging device of Denyer et al. to include a display for displaying an image on an array of $M \times N$ pixels. The motivation to do so would have been to improve the portability of the imaging device by allowing the user to review the captured image data on the same device.

32. **Regarding claim 45**, the combined teaching of Denyer et al. in view of Denyer et al. '434 further teaches that the interpolator estimates the color component level not measured in each respective photosensitive site in at least one line of photosensitive sites in the array during a readout operation (*Denyer et al. discloses that five lines of five pixels forming a block are read out from the array of photosensitive sites 23 and*

output to an A/D converter (A/D block as shown in fig. 7), that would further output the digitized signals to a five-line memory (Fig. 7: 26) and the subjected to color interpolation (using lowpass filter 28 and block 30 (which perform interpolation for determining the luminance values) to obtain the missing colors in a respective site) (See page 18, lines 5-30). Therefore, Denyer et al. discloses that the interpolator estimates the color component level not measured in each respective photosensitive site in at least one line of photosensitive sites in the array during a readout operation since the block in Denyer et al is formed by a plurality of lines).

33. **Regarding claim 46**, the combined teaching of Denyer et al. in view of Denyer et al. '434 further teaches that the interpolator estimates the color component level not measured in each respective photosensitive site in several sequential lines of photosensitive sites in the array during a readout operation (*Denyer et al. discloses that five lines of five pixels forming a block are read out from the array of photosensitive sites 23 and output to an A/D converter (A/D block as shown in fig. 7), that would further output the digitized signals to a five-line memory (Fig. 7: 26) and the subjected to color interpolation (using lowpass filter 28 and block 30 (which perform interpolation for determining the luminance values) to obtain the missing colors in a respective site) (See page 18, lines 5-30). Therefore, Denyer et al. discloses that the interpolator estimates the color component level not measured in each respective photosensitive site in several sequential lines of photosensitive sites in the array during a readout operation since the block in Denyer et al is formed by a plurality of sequential lines).*

34. **Regarding claim 47**, the combined teaching of Denyer et al. in view of Denyer et al. '434 further teaches that the interpolator estimates the color component level not measured in each respective photosensitive site in a block of photosensitive sites in the array during a readout operation (*Denyer et al. discloses that five lines of five pixels forming a block are read out from the array of photosensitive sites 23 and output to an A/D converter (A/D block as shown in fig. 7), that would further output the digitized signals to a five-line memory (Fig. 7: 26) and the subjected to color interpolation (using lowpass filter 28 and block 30 (which perform interpolation for determining the luminance values) to obtain the missing colors in a respective site) (See page 18, lines 5-30). Therefore, Denyer et al. discloses that the interpolator estimates the color component level not measured in each respective photosensitive site in a block of photosensitive sites in the array during a readout operation).*

35. **Regarding claim 48**, the combined teaching of Denyer et al. in view of Denyer et al. '434 further teaches a plurality of third photosensitive sites (*Fig. 7: 23; see also fig. 1; page 11, lines 29-37; page 12, lines 1-8*), said plurality of third photosensitive sites having a plurality of third color filters (*As shown in fig. 1, Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors. For examination purposes, the Examiner is interpreting the Blue color filters as the plurality of third color filters*) arranged above said third photosensitive sites to allow only a third spectral component of light to reach said third photosensitive sites (*Denyer et al. discloses that the pixels are covered with color filters corresponding to desired spectral components. See page*

12, lines 1-8. See also fig. 1, which shows the arrangement of Red, Green and Blue colors. This teaches that the third photosensitive sites are covered with a plurality of third color filters (corresponding to Blue color as interpreted by the Examiner) to allow only a third spectral component of light (Blue color) to reach said third photosensitive sites), wherein each third photosensitive site comprises a configuration enabling each third photosensitive site to measure the level of a third spectral component (Blue color component) in light received by the respective third photosensitive site (Since Denyer et al. discloses a checkerboard pattern filter for Red, Green, and Blue colors covering the array of photosensitive sites (See fig. 1). For examination purposes, the Examiner is interpreting the light received by the photosensitive sites with the Blue color filters as the third spectral component in light measured by the respective second photosensitive site), and

wherein the interpolator further comprises a configuration enabling the interpolator to estimate:

the level of the first color component (Green color) in the light received by at least one of the third photosensitive sites (photosensitive sites measuring Blue color) based on at least one digitized measurement of the first color component (Green color being digitized by A/D converter as shown in fig. 7. See page 18, lines 5-30) obtained respectively by at least one of the first photosensitive sites (photosensitive sites measuring Green color) (As discussed in claim 37, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement

of the first color component (Green color digitized by the A/D converter as shown in fig. 7) to estimate the level of the first color component (Green color) in the light received by at least one of the third photosensitive sites (Photosensitive sites measuring Blue color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained on the photosensitive sites measuring a different color (in this case Blue color) (See page 12, lines 10-19; page 18, lines 5-30)),

the level of the second color component (Red color) in the light received by at least one of the third photosensitive sites (photosensitive sites measuring Blue color) based on at least one digitized measurement of the second color component (Red color being digitized by A/D converter as shown in fig. 7. See page 18, lines 5-30) obtained respectively by at least one of the second photosensitive sites (photosensitive sites measuring Red color) (As discussed in claim 37, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the second color component (Red color digitized by the A/D converter as shown in fig. 7) to estimate the level of the second color component (Red color) in the light received by at least one of the third photosensitive sites (Photosensitive sites measuring Blue color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Red color) is obtained on the photosensitive sites measuring a different color (in this case Blue color) (See page 12, lines 10-19; page 18, lines 5-30)), and

the level of the third color component (*Blue color*) in the light received by at least one of the first photosensitive sites (*photosensitive sites measuring Green color*) and/or at least one of the second photosensitive sites (*photosensitive sites measuring Red color*) based on at least one digitized measurement of the third color component (*Blue color being digitized by A/D converter as shown in fig. 7. See page 18, lines 5-30*) obtained respectively by at least one of the third photosensitive sites (*photosensitive sites measuring Blue color*) (As discussed in claim 37, Denyer et al. discloses applying a low-pass filter (As shown in fig. 7: 28) to obtain the missing colors in a respective site. See page 12, lines 10-37. This teaches the use of at least one digitized measurement of the third color component (Blue color digitized by the A/D converter as shown in fig. 7) to estimate the level of the third color component (Blue color) in the light received by at least one of the first photosensitive sites (Photosensitive sites measuring Green color) and/or at least one of the second photosensitive sites (Photosensitive sites measuring Red color) since Denyer et al. discloses that by performing low-pass filter to the color components, a spatially smoothed version of the ideal color components (in this case Green color) is obtained on the photosensitive sites measuring a different color (in this case Green and Red color components) (See page 12, lines 10-19; page 18, lines 5-30)).

Contact

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nelson D. Hernández Hernández whose telephone

number is (571)272-7311. The examiner can normally be reached on 9:00 A.M. to 5:30 P.M.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lin Ye can be reached on (571) 272-7372. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/Nelson D. Hernández Hernández/
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